At the size at which sea scallops become recruited to the commercial fishery (70 mm shell height), ovary weight is rather small ranging between 1-2 g in all areas. By the time scallops have attained 90 mm (approximately a year later: see Table 20), however, the ovary has doubled in size resulting in a significant increase in reproductive potential. In terms of meat size, ovary weight increases roughly 50% for both Georges Bank and Mid-Atlantic scallops during the half-year period of growth required for individuals to go from 60 to 40 meat count; between 40 and 30 count, ovary weight further increases by 35-40% (Table 43). Hence, substantial gains in potential egg deposition may be attained by increasing the size at which scallops are initially harvested in the commercial fishery. This will enhance reproductive potential by both elevating the number and fecundity of the spawning population, and increasing the number of eggs per recruit (Garrod and Knights 1979).

Yield Per Recruit

Yield per recruit analyses were performed for the Georges Bank, Mid-Atlantic, and offshore Gulf of Maine populations using the allometric model of Paulik and Gales (1964) since the slopes of the shell height-meat weight regressions for these areas (Table 35) were significantly greater than 3.0 ($P<0.001$). Calculations were conducted using the von Bertalanffy growth parameters presented in Table 20 with age at recruitment (t_p: age at first vulnerability to fishing gear) = 2.0 years and maximum age attained (t_λ) = 20 years. Natural mortality (M) was assumed to be 0.1 (Merrill and Posgay 1964). All analyses were accomplished by varying fishing mortality (F) between 0.01 and 1.50 and age at first capture (t_c) between 2.0 and 11.0 years (Tables 44-46). Transverse isopleths were also calculated for ages at first capture corresponding to 25, 30, 40, and 60 meat count scallops (Table 47; Figure 39).

Maximum yield per recruit occurs at ages 8.0, 8.5, and 10.5 for the Georges Bank, Mid-Atlantic, and Gulf of Maine populations, respectively, at F levels near 1.5 (Tables 44-46). Only slight gains (<9%), however, are achieved by delaying the mean age at first capture beyond age 6 for Georges Bank and Mid-Atlantic scallops and age 7.5 for Gulf of Maine scallops. Moreover, at these latter ages, maximum yield per recruit is obtained at relatively moderate fishing mortality rates (F_{max} = 0.4-0.5). Under these conditions, similar absolute yield per recruit values would be realized in all three areas.

Historically, the age at first capture in all USA sea scallop fishing regions has averaged about 4 years. For this average age at entry, maximum yield per recruit in all three major geographical areas occurs when F = 0.3. In recent years (particularly 1980 and 1981 on Georges Bank and in the Gulf of Maine), however, cull size has declined to between 3 and 4 years as a result of increased fishery dependence on incoming recruitment. Although F_{max} values at t_c = 3.0 to 3.5 are approximately the same as for t_c = 4.0 years, yield per recruit values are 6-12% less (when F = 0.2-0.3). However, recent fishing mortality levels have been well in excess of F_{max} as evinced by sharp reductions in both commercial CPUE and research survey indices. For F levels between 0.7 and 1.0, differences in yield per recruit between age 3 and 4 scallops range from 44-77% of the age 3 values. At these fishing mortality rates, significant potential yield is forfeited by harvesting smaller-sized scallops. This is illustrated in the transverse isopleths relating yield per recruit at four different meat counts to fishing mortality rate (Figure 39). In all areas, the highest values occur at relatively low F levels (F_{max} = 0.20-0.33: Table 47) and yield per recruit increases as meat decreases over the entire range of fishing mortality (> F = 0.1).

Marginal gains in yield per recruit at F levels above $F_{0.1}$ (Gulland 1977: p. 10) are relatively minor; greater than 92% of maximum yield per recruit is achieved at $F_{0.1}$ in any of the areas for any of the four meat counts (Figure 39). Moreover, fishing at $F_{0.1}$ provides a higher yield per recruit than is attained for most F values above 0.5. Accordingly, substantial reductions in current fishing mortality rates could ensue and be accompanied by increases rather than losses in yield per recruit without any change in meat count. The greatest gains, however, would be effectuated by concurrent reductions in both fishing mortality and meat count (Table 47).

Assessment Implications and Projected Outlook

The Northwest Atlantic sea scallop fishery is currently in a transitional state. Total annual USA and Canadian landings from Georges Bank, the Mid-Atlantic, and the Gulf of Maine during 1976-1981 were the highest on record; total landings, however, declined 33% between 1978 and 1980. Landings in 1981 were slightly higher than in 1980 (19,475 vs 17,805 tons) due to increased effort in the Georges Bank fishery where landings rose by nearly 50%. Mid-Atlantic and Gulf of Maine landings declined by 59% and 33%, respectively, between 1980 and 1981, with Mid-Atlantic landings being the lowest in seven years.

During 1976-1980, annual nominal effort in each of the principal sea scallop fisheries sequentially increased, with the 1980 values in all areas the highest ever recorded. Initially, effort increases were in response to significantly improved resource abundance on Georges Bank and in the Mid-Atlantic resulting from outstanding recruitment of the 1972 year class. In the Gulf of Maine, newly discovered offshore beds prompted increases in exploitation. Apart from the Northern Edge and Peak region of Georges Bank, subsequent scallop recruitment has